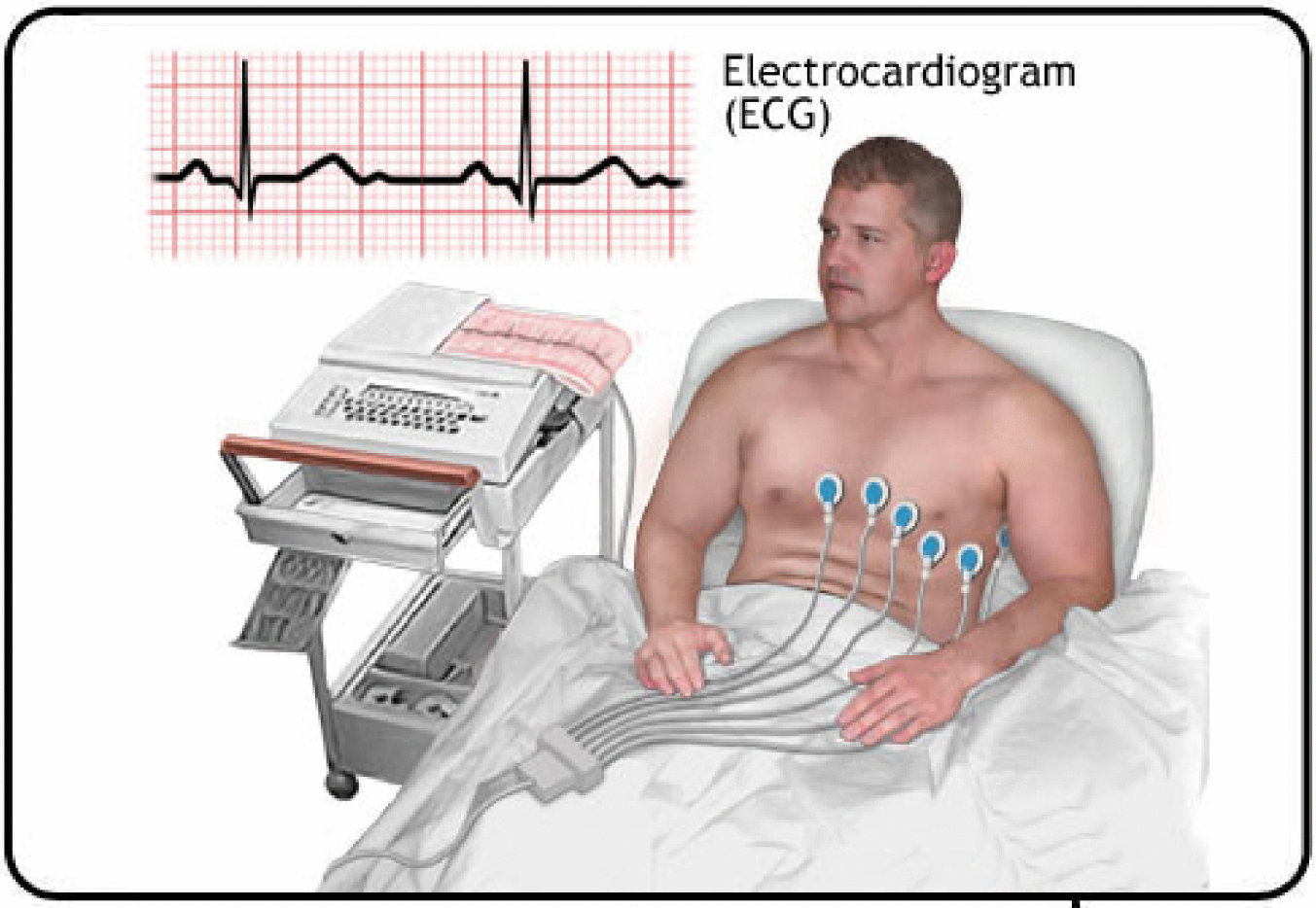
Summary of ECG



Notes of MedadTeam

- Special thanks to Dr Ashraf Zaki

2010

1.5 L.E.

MedadTeam

Summary of ECG

1. Take a look at the leads & determine location of each wall:

I High lateral	aVR	V1 Septal	V4 Strict anterior
II Inferior	aVL High lateral	V2 Septal	V5 Low lateral
III Inferior	aVF Inferior	V3 Strict anterior	V6 Low lateral
II			

2. Make spot diagnosis

3. Use the scheme to:
   - Confirm diagnosis
   - Correct diagnosis
   - Complete diagnosis

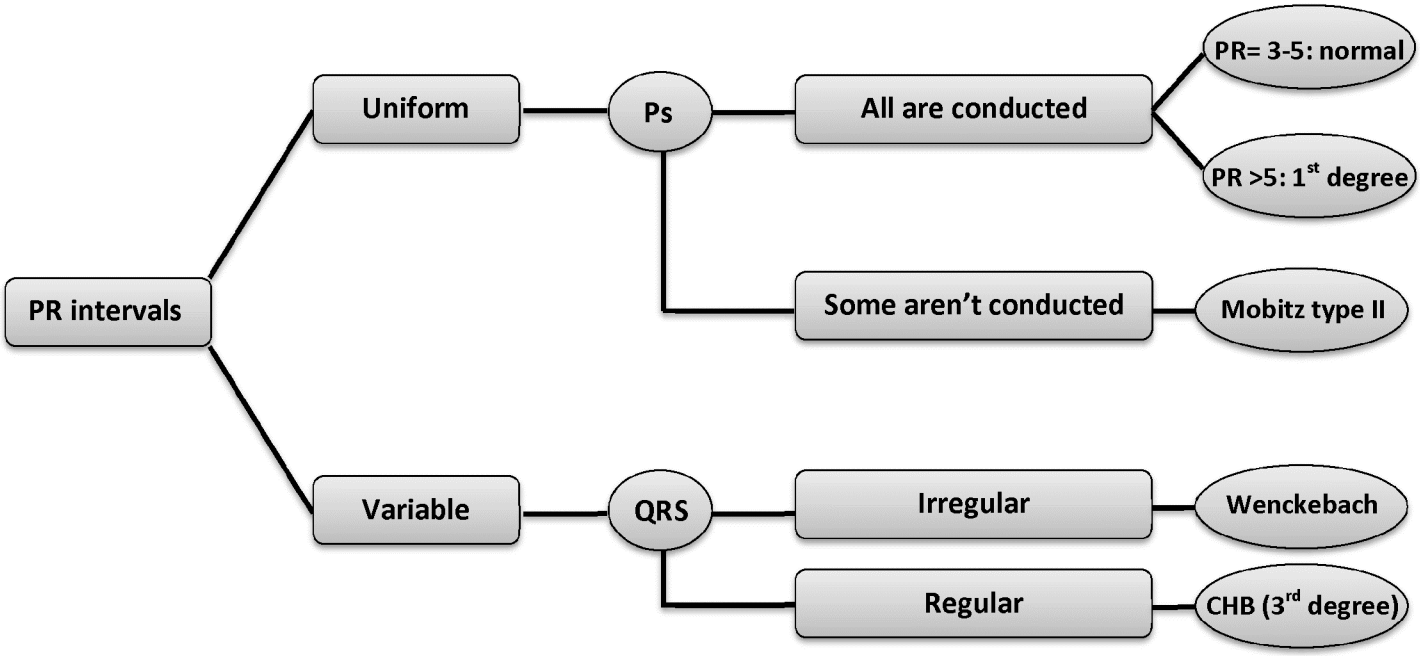
Scheme for ECG

	Abnormality	Leads to look at	
		Limb leads	Chest leads
Step I	**AV block**	Strip or II	
	Arrhythmia		
Step II	**Atrial enlargement**	II	V1
	Bundle Branch Block		V1, V2, V5, V6
	Ventricular enlargement		
Step III	**Axis**	I/III or aVF	
	Hemiblock	Limb leads	
Step IV	**Myocardial infarction**	I, L → high lateral wall II, III, F → inferior wall V1, V2 → septal wall V3, V4 → strict anterior wall V5, V6 → low lateral wall	
	Myocardial ischemia		
Step V	**Low voltage**	I, II, III	
	Digitalis	In all limb leads	
	Hyperkalemia	In all limb leads	
	Pre-excitation syndrome	In all limb leads	

Normally:

- **P wave**: height ≤2.5 small squares – width < 3 small squares.
- **PR interval (P wave + PR segment)**: width= 3-5 small squares.
- **QRS**: width < 2.5 small squares – height in LI + LII + LIII > 15 small squares.

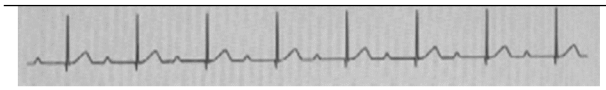
Step 1:
I.1 Atrioventricular Block



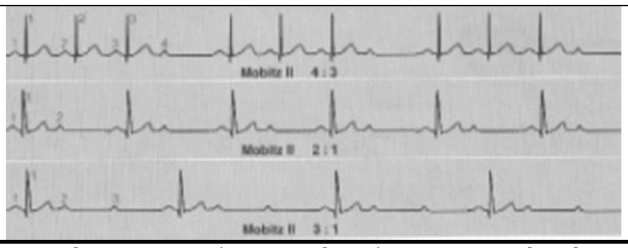
In second degree only (wenckebach & Mobitz type II):

1- Detect degree of block (P: QRS ratio -> 6:5 or 5:4 or 4:3 etc.....).
2- If block is 2:1, look at the width of the QRS:
   - If wide > 2.5 = Mobitz type II.
   - If narrow = wenckebach.
3- If shortest PR > 5 in wenckebach or PR > 5 in Mobitz type II = 1st degree Av block is associated.

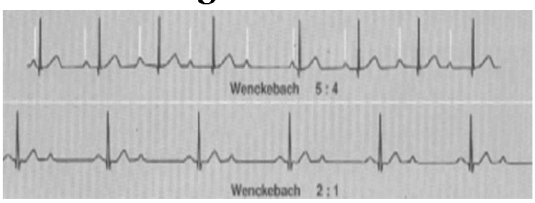
First Degree AV Block



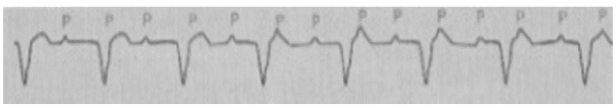
Mobitz Type II Second Degree AV Block



Mobitz Type I (Wenckebach) Seconed Degree AV Block



3rd Degree (Complete) Heart Block



I.2 Arrhythmia:

1. Regularity:

- **Regular:**
  Definition: uniform R-R intervals +/- 1mm
  How to decide:
  - By paper or divider
  - If NO strip: compare R-R intervals in different leads
  - If NO R-R in leads: do NOT comment on regularity
- **Irregular:**
  Definition: variable R-R
  Possibilities:
  - Regular irregularity
  - Irregular irregularity
- **Regular with occasional irregularity:**
  Definition: ALL R-R are regular except one i.e. premature beat

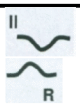
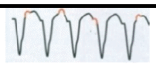
2. Rate: (heart rate)

- **If regular R-R interval:**
  Count number of squares (big or small) in R-R interval
  $\text{Rate} = \frac{300}{\text{R–R in big squares}}$ or $\frac{1500}{\text{R–R in small squares}}$
- **If irregular R-R interval:**
  - If strip is
    10 big squares, so rate = number of QRS X 30
    20 big squares, so rate = number of QRS X 15
    30 big squares, so rate = number of QRS X 10
  - Whether strip is present or not, choose THE MOST MIDDLE R-R INTERVAL(استوسطلك واحدة),
    So rate = $\frac{300}{\text{MOST MIDDLE R–R in big squares}}$

If NO strip & NO R-R in leads (one complex in each lead), do NOT comment

3. Pacemaker:

Scheme for pacemaker				
Pacemaker	How to know		If the pacemaker is ..., so think about	
Sinus pacemaker	P wave: - Upright in II & - Inverted in aVR		**Normal sinus rhythm** **Sinus tachycardia** **Sinus bradycardia** **Sinus arrhythmia** **Sinus pause**	Differentiated by **regularity & rate**
Atrial pacemaker	NO sinus P wave P wave according to rhythm		**Atrial ectopic focus** **Atrial fibrillation** **Atrial flutter** **Multifocal atrial tachycardia** **Wandering atrial tachycardia**	Differentiated by **features of each pacemaker**

Junctional pacemaker	P wave: - Absent OR - Retrograde: Inverted in II, Upright in aVR Just before or just after QRS		**Supraventricular tachycardia** **Escape Junctional rhythm** **Accelerated Junctional rhythm**	Differentiated by **rate** (as ALL are regular)
Ventricular pacemaker	- Wide QRS Except suprahesal - T direction is opposite to QRS - +/- signs of AV dissociation		**Ventricular tachycardia** **Escape idioventricular rhythm** **Accelerated idioventricular rhythm**	Differentiated by **rate** (as ALL are regular except multifocal VT)
			Ventricular fibrillation **Ventricular flutter**	**Spot diagnosis**
Artificial pacemaker	Spikes before QRS +/-P wave		**Ventricular pacemaker** **Dual pacemaker**	Differentiated by **spikes**

For determining type of arrhythmia

1. **Determine the pacemaker**
2. **Decide which type of arrhythmia according to the rate and regularity**

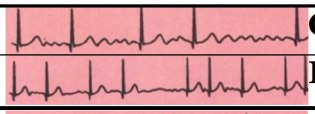
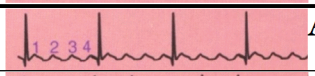
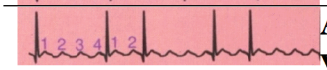
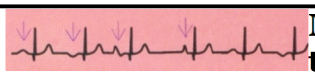
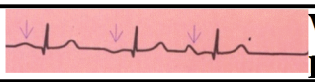
I. Sinus pacemaker:

Scheme for Sinus Pacemaker

1.pacemaker	2. decide arrhythmia			
	Regularity	Rate	Lead II (Strip)	Rhythm (Diagnosis)
Sinus rhythm P wave: • Upright in II • Inverted in aVR	Regular	**60-100**		**Normal sinus rhythm**
		100-180		**Sinus tachycardia**
		40-60		**Sinus bradycardia**
	Irregular	Any		**Sinus arrhythmia**
	Regular with OI (Dropped beat)			**Sinus pause (Sick Sinus Syndrome)**

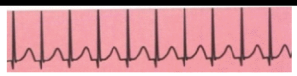
II. Atrial pacemaker:

Scheme for Atrial Pacemaker

1.pacemaker	2.deciding arrhythmia				
	Pacemaker	Regularity	Rate	Lead II (Strip)	Rhythm (Diagnosis)
Atrial pacemaker NO sinus P wave	Small P waves	Regular	>150		**Supraventricular tachycardia**
	Fibrillatory waves Absent P	Irregular	Any		**Coarse** / **Fine** — **Atrial fibrillation**
	Flutter waves (Saw teeth)	**Regular**	Any		**Atrial flutter 4:1**
		Irregular			**Atrial flutter with variable block**
	≥ 3 different Ps	Irregular	**Tachycardia**		**Multifocal atrial tachycardia (MAT)**
			Bradycardia		**Wandering atrial pacemaker**

III. Junctional pacemaker:

Scheme for Junctional Pacemaker

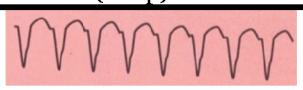
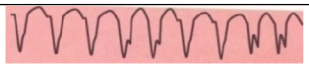
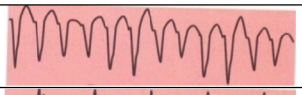
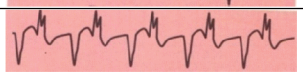
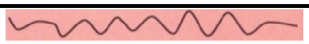
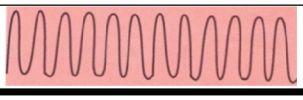
1.pacemaker	2.decide arrhythmia			
	Regularity	Rate	Lead II (Strip)	Rhythm (Diagnosis)
Junctional Pacemaker P absent or retrograde	Regular	**>150 (>100)**		**Supraventricular tachycardia (PAVNRT)**
		40-60		**Escape Junctional rhythm**
		60-100		**Accelerated Junctional rhythm**

ALL junctional rhythms are REGULAR, unlike fine AF which is IRREGULAR

Junctional rhythm (supraventricular tachycardia)	**Atrial Fibrillation**
Absent P wave	
Regular	Irregular

IV. Ventricular pacemaker:

Scheme for ventricular Pacemaker

1.pacemaker	2.decide arrhythmia				
	Pacemaker	Regularity	Rate	Lead II (Strip)	Rhythm (Diagnosis)
Ventricular pacemaker Wide QRS T inversion AV dissociation			**>150**		**Ventricular tachycardia**
			<40		**Escape idioventricular rhythm**
			60-100		**Accelerated idioventricular rhythm**
				Don't exceed 30 seconds 3 or more beats	**NON sustained ventricular tachycardia**
		Irregular	Tachy		**Multifocal ventricular tachycardia**
					**Torsades de pointes**
					**Bidirectional Ventricular tachycardia**
NO QRS	**Vent. fibrillatory waves**	Irregular	Any		**Ventricular fibrillation**
	Ventricular flutter waves	Regular	300-400		**Ventricular flutter**

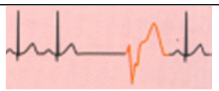
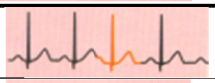
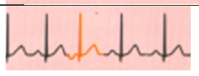
V. Ectopic beats

Scheme for Ectopic Beats

1. Decide whether ectopic beat is escape or premature

If	,so
Sinus rhythm →pause →ectopic beat →sinus rhythm	**Escape beat**
Sinus rhythm →ectopic beat →pause →sinus rhythm	**Premature beat**

2.Decide whether ectopic beat (escape or premature) is atrial, Junctional or ventricular

If		,So diagnosis
Small (atrial) P wave		**Escape atrial beat**
Retrograde P wave		**Escape Junctional beat**
Wide QRS T wave opposite QRS		**Escape ventricular beat**
Small (atrial) P wave		**Premature atrial beat**
Retrograde P wave		**Premature Junctional beat**
Wide QRS T wave opposite QRS		**Premature ventricular beat**

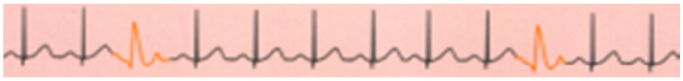
Premature	Pause
Less than	2 Normal cycles

Premature	Pause
equal	2 Normal cycles

Variable forms of premature beats:

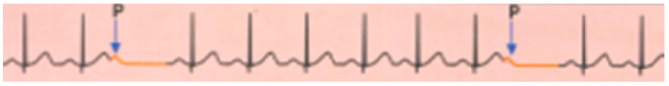
1) Premature atrial beat with aberrant conduction (Ashmann phenomenon):

Premature atrial beat occurs so early that it reach the ventricles during relative refractory period.
So upstroke of ventricular depolarization is slow and intraventricular conduction of the impulse is slow with subsequent wide QRS.



2) Premature atrial beat with non-conducted P:

Premature atrial beat occurs more early than the mentioned above, so it reaches the ventricels during absolute refractory period → no QRS



3) Monofocal premature beat:

Scheme for Monofocal Premature Beat

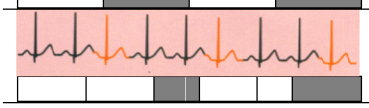
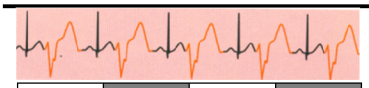
Monofocal premature beat

Premature beat occurs every constant number of sinus beats

1.Decide whether premature beats are atrial or ventricular

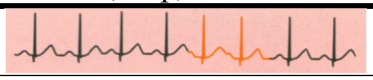
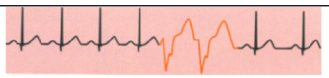
If	,So
Small P wave	**Atrial premature beats**
Wide QRS T wave opposite QRS	**Ventricular premature beat**
Retrograde P wave	**Junctional premature beats**

2.Decide whether premature beats are bigeminy, trigeminy or quadrigeminy

If (Strip)	,So
	**Atrial bigeminy**
	**Atrial trigeminy**
	**Atrial quadrigeminy**
	**Ventricular bigeminy**
	**Ventricular trigeminy**
	**Ventricular quadrigeminy**
	**Junctional bigeminy**
	**Junctional trigeminy**
	**Junctional quadrigeminy**

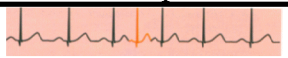
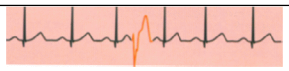
4) Couplet:

Scheme for Couplet

How to know		If	Lead II (Strip)	,So diagnosis
Sinus rhythm →premature beat →premature beat →sinus rhythm	Couplet	Small P wave		**Atrial couplet**
		Retrograde P wave		**Junctional couplet**
		Wide QRS T wave opposite QRS		**Ventricular couplet**

5) Interpolated premature beat:

Scheme for Interpolated Premature Beat

How to know		If	Lead II (Strip)	,So
Sinus rhythm →premature beat →sinus beat (NO pause) Premature cycle + return cycle = **ONE** normal sinus cycle	Interpolated premature beat	Small P wave		**Interpolated PAB**
		Retrograde P wave		**Interpolated PJB**
		Wide QRS T wave opposite QRS		**Interpolated PVB**

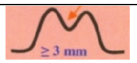
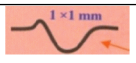
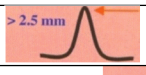
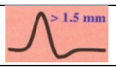
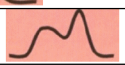
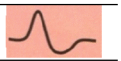
Step II

II.1. Atrial enlargement:

Look at

		V1	
II			

Scheme for atrial enlargement

	II			V1	
Normal	Positive, W<3mm, H≤ 2.5mm			Biphasic	
Left	Broad, P mitral	W>=3mm +/- notched		-ve > 1x1	
Right	Tall and peaked, P pulmonale	H>2.5		+ve > 1.5 in H	
Biatrial	P mitral & P pulmonale			+ve P is tall >1.5 & -ve P is board >1	

For diagnosis of atrial enlargement, a change in ONE lead is ENOUGH

II.2. Bundle Branch Block:

Look at

		V1	
		V2	V5
			V6

Spot diagnosis: WIDE QRS at V1, V2, V5, V6

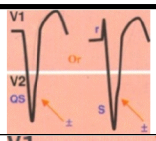
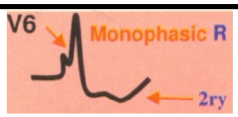
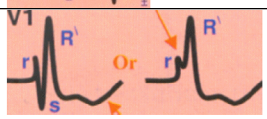
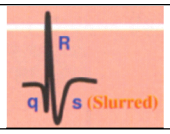
i. Is QRS complex (Normal < 2.5mm) wide?

If >3mm → complete BBB

If 2.5-3mm → incomplete BBB

ii. In both cases, determine whether right or left:

Scheme for Bundle Branch Block

	V1, V2		V5, V6 & I	
LBBB	QS or rS		Monophasic R with secondary inversion of T wave	
RBBB	rSR' or monophasic R with secondary inversion of T wave		qRs (with slurred s)	
IVCD	LBBB		+ RBBB	
	RBBB		+ LBBB	

➢ **If RBBB is diagnosed, NEVER diagnose:**

- **Ventricular enlargement**
- **Myocardial ischemia**

➢ **If LBBB is diagnosed, NEVER diagnose : above conditions+**

- **Myocardial infarction** (diagnosed if new onset LBBB with typical ischemic chest pain or elevated cardiac enzymes)
- **Hemiblock.**

➢ Pacemaker: in LBBB ONLY (or IVCD)

If LBBB is associated with spikes, this indicates pacemaker:

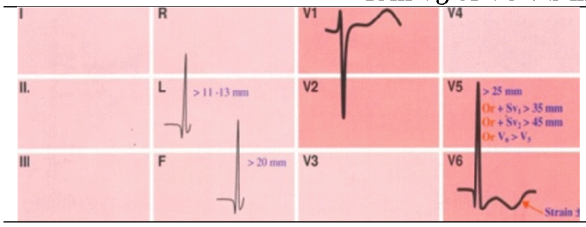
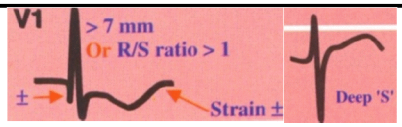
- **If one spike (before QRS) → ventricular pacemaker**
- **If TWO spikes (one before P, and other before QRS) → Dual pacemaker**
- **If spike is NOT followed by QRS → malfunctioning pacemaker**

II.3. Ventricular enlargement:

Look at

		V1	
		V2	V5
			V6

Scheme for Ventricular Enlargement

	V1, V2	V5, V6
LVE	6 features (ANY one is diagnostic, but ALL must be excluded negative to exclude LVE)	
		R in V5 or V6 > **25 mm** (5 big squares)
	R in V5 or V6 + S in V1 > **35 mm** (7 big squares) R in V5 or V6 + S in V2 > **45 mm** (9 big squares)	
		R in V6 > R in V5
	R in aVL > **13 mm** R in aVF > **20 mm**	+/- ST depression(strain sign) = hypertrophy > dilatation
RVE	Tall R in V1 > 7 mm or R in V1 ≥ S in V1 Deep S in V6 +/- ST depression(strain sign) = hypertrophy > dilatation	
BVE	Signs of LVE + tall R in V1 or Signs of LVE + Rt. Axis deviation.	

Step III

III.1. Axis:

Look at:

I			
III	aVF		

Scheme for Axis

	Normal axis deviation	Left axis deviation	Right axis deviation	Extreme axis deviation
I				
III or aVF				

IF THE AXIS IS DEVIATED, SEARCH FOR HEMIBLOCK

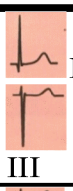
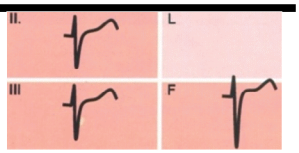
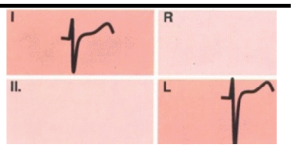
III.2. Hemiblock:

Look at: inferior and high lateral leads

I			
II	aVL		
III	aVF		

Search for hemiblock if axis is deviated

Scheme for Hemiblock

LAHB Left anterior HB	Left axis deviation		Deep S in inferior leads (II, III, aVF) in aVF especially (as normal in III) (NO need to exclude other causes of left axis deviation)	
LPHB Left posterior HB	Right axis deviation		Deep S in high lateral leads (I, aVL) (provided that it is NOT explained by RVE)	

NB | If hemiblock + RBBB → **Bifascicular block hemiblock**
If hemiblock + RBBB + 1st HB → **Trifascicular block hemiblock**

Step IV

IV.1.2. Myocardial infarction and ischemia:

Search for ALL changes in EACH lead

Changes:

i. Is there Pathological Q (or poor progression of R)?
ii. Is there ST elevation (or ST depression)?
iii. Is there T inversion (or hyperacute, biphasic or flat T wave)?

CHANGES must be in 2 SUCCESSIVE LEADS of the SAME WALL

- **Pathological Q:**
  - Wide (≥ 1mm) & deep (≥= 2mm or ≥ ¼ the following R)
  - In 2 successive lead of the same wall
- **Poor progression of R: in anterolateral infarction**
  - R is NOT >S in V4
- **ST elevation:**
  - First mm after J point is elevated than isoelectric line
  - Isoelectric lines (baseline) are P-R segment or T-P segment
  - Considered elevated if:
    - ≥ 1mm in limb leads
    - ≥ 2mm in chest leads

- Determine straightened or coved according to T wave & J point elevation
- **These changes MUST be IN 2 SUCCESSIVE LEADS of the SAME WALL**

If:

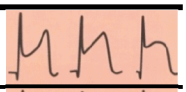
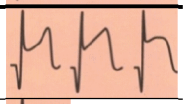
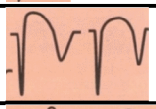
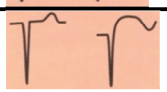
- ST elevation (+/- ST depression in other walls) → **ST elevation Myocardial Infarction (+/- reciprocal ST depression)**
- ST depression ONLY → **Myocardial ischemia**

If ST Elevation Myocardial Infarction, determine age & site:

1. Age:

Scheme for age of STEMI

Spot diagnosis

Age of STEMI	How to know			
	ST segment	Q wave	T wave	
Hyperacute	ST elevation	NO pathological Q	+/- Hyperacute T wave	
Acute	ST elevation	Pathological Q Or poor R progression	+/- Hyperacute T wave	
			Biphasic (intermediate phase)	
Evolving	ST elevation	Pathological Q Or poor R progression	Inverted T	
Old	NO ST elevation	Pathological Q Or poor R progression	Normal T	

2. Site:

I High lateral	aVR	V1 Septal	V4 Strict anterior
II Inferior	aVL High lateral	V2 Septal	V5 Low lateral
III Inferior	aVF Inferior	V3 Strict anterior	V6 Low lateral

Anteroseptal = V1-V3 +\- V4

Anterolateral =V3-V6+I&aVL

Extensive anterior= V3-V6+I&aVL

Posterior wall MI:

Tall R in V1, V2, V3 – ST depression – upright T

- Associated with inferior myocardial infarction (to differentiate it form RVE)

RVE	Posterior MI
Tall R in V1, V2, V3	
Associated with Inferior MI	

ST depression in some leads:

- If associated with ST elevation in other leads → **RECIPROCAL ST DEPRESSION associated with MI**

-If alone → **MYOCARDIAL ISCHEMIA:**

ST depression: start after J point, is ≥ 1mm in limb leads or ≥2mm in chest leads & last for >2mm.

T wave: flat or symmetrically inverted or symmetrically upright.

Step V

V.1. Low voltage:

Look at

I			
II			
III			

How to know

- QRS in I + II + III < 15mm

NB | **Electrical alternans in pericardial effusion:**

- LOW voltage

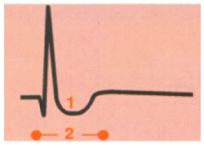
+

V.2. Digitalis effect: in ALL LEADs

Digitalis effect:

NB | Normal QT = ½ RR

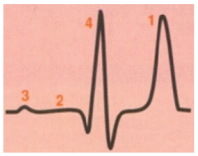
- Short QT i.e. QT < ½ RR
- Sagging ST depression:
  - J point is isoelectric (unlike ischemia)
  - ST depression + T inversion
  - Fused ST & T



V.3. Hyperkalemia: in ALL LEADs

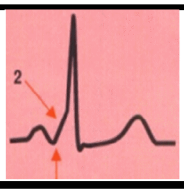
How to know:

Hyperacute T wave alone (tall, narrow & peaked)



V.4. Preexcitation syndrome: in ALL LEADs

Scheme for prexcitation syndromes

WPW-Wolf Parkinson White		LGL-Lawn Ganong Levine	
• Short PR interval • Delta wave • Wide QRS		• Short PR interval